

CLAIMS

What is claimed is:

1. A method for transporting gas, comprising:
dissolving the gas in an emulsion comprising a fluorinated hydrocarbon, a surfactant and an aqueous electrolyte with a pH of at most 4 or at least 9; and
contacting the emulsion with an electrode.

2. The method of claim 1, wherein:
the aqueous electrolyte has a pH of at most 3.

3. The method of claim 1, wherein:
the aqueous electrolyte comprises an acid dissolved in water, and the acid comprises a member selected from the group consisting of:
 H_2SO_4 , HNO_3 , HClO_4 , H_3PO_3 , H_3PO_4 , HCl , HBr , HI , $\text{CH}_3\text{CO}_2\text{H}$,
 $\text{CCl}_3\text{CO}_2\text{H}$, $\text{CF}_3\text{CO}_2\text{H}$, and mixtures thereof.

4. The method of claim 1, wherein:
the aqueous electrolyte comprises an aqueous solution of H_2SO_4 .

5. The method of claim 1, wherein:
the aqueous electrolyte has a pH of at least 10.

6. The method of claim 1, wherein:
the aqueous electrolyte comprises a base dissolved in water, and the base comprises a member selected from the group consisting of:
 LiOH , NaOH , KOH , Rb(OH) , CsOH , Mg(OH)_2 , Ca(OH)_2 , Sr(OH)_2 ,
and Ba(OH)_2 , and mixtures thereof.

7. The method of claim 1, wherein:

the fluorinated solvent is selected from the group consisting of:

(C_nF_{2n+1})Si(OCH₃)₃; (C_nF_{2n+1})₂Si(OCH₃)₂; (C_nF_{2n+1})CH₂OC(O)CH₃;
CF₃[OCF₂CF₂]_nOCF₃; CF₃[OCF₂CF₂]_nOCF₂Cl; CF₃[OCF₂CF₂]_nOCF₂Br;
CF₃[OCF₂CF₂]_nCF₂H; CF₃[OCF₂CF₂]_nF; CF₃[OCF₂CF₂]_nCl; CF₃[OCF₂CF₂]_nBr;
CF₃[OCF₂CF₂]_nH; CF₃CF₂[OCF₂CF₂]_nF; CF₃CF₂[OCF₂CF₂]_nCl; CF₃CF₂[OCF₂CF₂]_nBr;
CF₃CF₂[OCF₂CF₂]_nH; CF₃CHF[OCF₂CF₂]_nF; CF₃CHF[OCF₂CF₂]_nCl;
CF₃CHF[OCF₂CF₂]_nBr; CF₃CHF[OCF₂CF₂]_nH; CF₃CHF[OCF₂CF(CF₃)]_nF;
(CF₃)₂CF(CF₂)_nF; (CF₃)₂CF(CF₂)_nCl; (CF₃)₂CFO(CF₂)_nBr; (CF₃)₂CFO(CF₂)_nH; C_nF_{2n+2};
(CF₃)₂CFO(CF₂)_nF; (CF₃)₂CFO(CF₂)_nCl; (CF₃)₂CFO(CF₂)_nBr; (CF₃)₂CFO(CF₂)_nH; C_nF_{2n+2};
CF₃(CF₂)_nCl; CF₃(CF₂)_nHCF₃(CF₂)_nBr; N(C_nF_{2n+1})₃ wherein n is 1 to 20; C₆F_mH_{6-m}, C₆F_mCl_{6-m}, C₆F_mBr_{6-m}, C₆F_m(CF₃)_{6-m}, wherein m is 1 to 6; and mixtures thereof.

8. The method of claim 1, wherein:

the fluorinated solvent is selected from the group consisting of:

CF₃(CF₂)₇Br; (CF₃)₂CF(CF₂)₄Cl; (CF₃)₂CFO(CF₂)₆F;
perfluorobutyltetrahydrofuran; perfluoropropyltetrahydropyran; C₈F₁₈; CF₃CFBrCF₂Br;
(CF₃)₂CF(CF₂)₄Br; [(CF₃)₂CFOCF₂CF₂]₂; C₉F₂₀; C₆F₆; CF₃CHF[OCF₂CF(CF₃)]₃F;
(CF₃)₂CF(CF₂)₆Cl; C₁₀F₁₆; CF₃CHF[OCF₂CF(CF₃)]₄F;
perfluorotetrahydronorbornadiene; [(CF₃)₂CFO(CF₂)₄]₂; perfluorodecalin;
CF₃CHF[OCF₂CF(CF₃)]₅F; perfluorodimethyladamantane; N(C₄F₉)₃;
perfluoromethyldecalin; C₆H₄(CF₃)₂; and CF₃CHF[OCF₂CF(CF₃)]₉F, and mixtures thereof.

9. The method of claim 1, wherein:

the fluorinated solvent is perfluorodecaline.

10. The method of claim 1, wherein:

the surfactant is selected from the group consisting of:

F(CF₂CF₂)_y(CH₂CH₂O)_xH, wherein y is 1 to 10, and x is 0 to 25;
((F(CF₂CF₂)_yCH₂CH₂)_xP(O)(ONH₄)_y, wherein x is 1 or 2, y is 1 or 2, x + y is 3, and z is 1 to

8; $F(CF_2CF_2)_xCH_2CH_2SCH_2CH_2CO_2Li$, wherein x is 1 to 10; $F(CF_2CF_2)_xCH_2CH_2SO_3Y$, wherein x is 1 to 10, and Y is H^+ or NH_4^+ ; and mixtures thereof.

11. The method of claim 1, wherein:

the surfactant is a mixture of $CF_3(CF_2)_5CH_2CH_2SO_3H$ and $CF_3(CF_2)_5CH_2CH_2SO_3NH_4$.

12. The method of claim 1, wherein:

the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 1:24 to 24:1.

13. The method of claim 1, wherein:

the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 3:24 to 12:24.

14. The method of claim 1, wherein:

the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 1:6 to 5:7.

15. The method of claim 1, wherein:

the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 2:9 to 4:9.

16. The method of claim 1, wherein:

The amount of surfactant in the emulsion is from 0.07% to 3% of the total weight of the emulsion.

17. The method of claim 1, wherein:

The amount of surfactant in the emulsion is from 0.125% to 2% of the total weight of the emulsion.

18. The method of claim 1, wherein:

The amount of surfactant in the emulsion is from 0.5% to 1% of the total weight of the emulsion.

19. The method of claim 1, wherein:

the gas comprises oxygen.

20. A composition for delivering gas and ions to an electrode, comprising:

an emulsion comprising:

a fluorinated hydrocarbon;

a surfactant; and

an aqueous electrolyte with a pH of at most 4 or at least 9.

21. The composition of claim 20, wherein:

the aqueous electrolyte has a pH of at most 3.

22. The composition of claim 20, wherein:

the aqueous electrolyte has a pH of at most 1.

23. The composition of claim 20, wherein:

the aqueous electrolyte comprises a member selected from the group consisting of:

H₂SO₄, HNO₃, HClO₄, H₃PO₃, H₃PO₄, HCl, HBr, HI, CH₃CO₂H, CCl₃CO₂H, CF₃CO₂H, and mixtures thereof.

24. The composition of claim 20, wherein:

the electrolyte comprises an aqueous solution of H₂SO₄.

25. The composition of claim 20, wherein:

the aqueous electrolyte has a pH of at most 10.

26. The composition of claim 20, wherein:

the aqueous electrolyte comprises a member selected from the group consisting of:

LiOH, NaOH, KOH, Rb(OH), CsOH, Mg(OH)₂, Ca(OH)₂, Sr(OH)₂,

and Ba(OH)₂, and mixtures thereof.

27. The composition of claim 20, wherein:

the fluorinated solvent is selected from the group consisting of:

(C_nF_{2n+1})Si(OCH₃)₃; (C_nF_{2n+1})₂Si(OCH₃)₂; (C_nF_{2n+1})CH₂OC(O)CH₃;
CF₃[OCF₂CF₂]_nOCF₃; CF₃[OCF₂CF₂]_nOCF₂Cl; CF₃[OCF₂CF₂]_nOCF₂Br;
CF₃[OCF₂CF₂]_nCF₂H; CF₃[OCF₂CF₂]_nF; CF₃[OCF₂CF₂]_nCl; CF₃[OCF₂CF₂]_nBr;
CF₃[OCF₂CF₂]_nH; CF₃CF₂[OCF₂CF₂]_nF; CF₃CF₂[OCF₂CF₂]_nCl; CF₃CF₂[OCF₂CF₂]_nBr;
CF₃CF₂[OCF₂CF₂]_nH; CF₃CHF[OCF₂CF₂]_nF; CF₃CHF[OCF₂CF₂]_nCl;
CF₃CHF[OCF₂CF₂]_nBr; CF₃CHF[OCF₂CF₂]_nH; CF₃CHF[OCF₂CF(CF₃)]_nF;
(CF₃)₂CF(CF₂)_nF; (CF₃)₂CF(CF₂)_nCl; (CF₃)₂CFO(CF₂)_nBr; (CF₃)₂CFO(CF₂)_nH;
(CF₃)₂CFO(CF₂)_nF; (CF₃)₂CFO(CF₂)_nCl; (CF₃)₂CFO(CF₂)_nBr; (CF₃)₂CFO(CF₂)_nH; C_nF_{2n+2};
CF₃(CF₂)_nCl; CF₃(CF₂)_nHCF₃(CF₂)_nBr; N(C_nF_{2n+1})₃ wherein n is 1 to 20; C₆F_mH_{6-m}, C₆F_mCl_{6-m}, C₆F_mBr_{6-m}, C₆F_m(CF₃)_{6-m}, wherein m is 1 to 6; and mixtures thereof.

28. The composition of claim 20, wherein:

the fluorinated solvent is selected from the group consisting of:

CF₃(CF₂)₇Br; (CF₃)₂CF(CF₂)₄Cl; (CF₃)₂CFO(CF₂)₆F;

perfluorobutyltetrahydrofuran; perfluoropropyltetrahydropyran; C₈F₁₈; CF₃CFBrCF₂Br;

$(CF_3)_2CF(CF_2)_4Br$; $[(CF_3)_2CFOCF_2CF_2]_2$; C_9F_{20} ; C_6F_6 ; $CF_3CHF[OCF_2CF(CF_3)]_3F$;
 $(CF_3)_2CF(CF_2)_6Cl$; $C_{10}F_{16}$; $CF_3CHF[OCF_2CF(CF_3)]_4F$;
perfluorotetrahydrocyclopentadiene; $[(CF_3)_2CFO(CF_2)_4]_2$; perfluorodecalin;
 $CF_3CHF[OCF_2CF(CF_3)]_5F$; perfluorodimethyladamantane; $N(C_4F_9)_3$;
perfluoromethyldecalin; $C_6H_4(CF_3)_2$; and $CF_3CHF[OCF_2CF(CF_3)]_9F$; and mixtures thereof.

29. The composition of claim 20, wherein:
the fluorinated solvent is perfluorodecaline.

30. The composition of claim 20, wherein:
the surfactant is selected from the group consisting of:
 $F(CF_2CF_2)_y(CH_2CH_2O)_xH$, wherein y is 1 to 10, and x is 0 to 25;
 $((F(CF_2CF_2)_yCH_2CH_2)_xP(O)(ONH_4))_z$, wherein x is 1 or 2, y is 1 or 2, x + y is 3, and z is 1 to 8; $F(CF_2CF_2)_xCH_2CH_2SCH_2CH_2CO_2Li$, wherein x is 1 to 10; $F(CF_2CF_2)_xCH_2CH_2SO_3Y$, wherein x is 1 to 10, and Y is H^+ or NH_4^+ ; and mixtures thereof.

31. The composition of claim 20, wherein:
the surfactant is a mixture of $CF_3(CF_2)_5CH_2CH_2SO_3H$ and
 $CF_3(CF_2)_5CH_2CH_2SO_3NH_4$.

32. The composition of claim 20, wherein:
the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 1:24 to 24:1.

33. The composition of claim 20, wherein:
the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 3:24 to 12:24.

34. The composition of claim 20, wherein:

the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 1:6 to 5:7.

35. The composition of claim 20, wherein:
the volume-to-volume ratio of fluorinated solvent to aqueous electrolyte in the emulsion is from 2:9 to 4:9.
36. The composition of claim 20, wherein:
the amount of surfactant in the emulsion is from 0.07% to 3% of the total weight of the emulsion.
37. The composition of claim 20, wherein:
the amount of surfactant in the emulsion is from 0.125% to 2% of the total weight of the emulsion.
38. The composition of claim 20, wherein:
The amount of surfactant in the emulsion is from 0.5% to 1% of the total weight of the emulsion.
39. A fuel cell for the generation of electricity, comprising:
 - a) an anode;
 - b) a cathode; and
 - c) a composition in contact with at least one of the anode and the cathode comprising:
an emulsion comprising a fluorinated solvent, a surfactant and an aqueous electrolyte with a pH of at most 4 or at least 9.
40. The fuel cell of claim 39, wherein:

the fuel cell is a fuel cell wherein the cathode and the anode are separated by a membrane.

41. The fuel cell of claim 39, wherein:

the anode and the cathode are separated by a channel contiguous with at least a portion of each electrode;

such that when a first liquid is contacted with the anode, a second liquid is contacted with the cathode, and the first and the second liquids flow through the channel, a parallel laminar flow is established between the first and the second liquid.

42. The fuel cell of claim 39, wherein:

the composition in contact with the anode further comprises a fuel.

43. The fuel cell of claim 39, wherein:

the composition in contact with the cathode further comprises oxygen.

44. In a fuel cell comprising:

a) an anode; and

b) a cathode;

the improvement comprising:

transporting a gas to at least one of the anode and the cathode by:

dissolving the gas in an emulsion comprising a fluorinated solvent, a surfactant and an aqueous electrolyte with a pH of at most 4 or at least 9; and

contacting the emulsion with at least one of the anode and the cathode.